Marwadi University
Marwadi Chandarana Group

Syllabus for Diploma Engineering

Electrical Engineering

Semester – V

Subject Name: Switchgear & Protections

Subject Code: 09EE2501

Diploma Branches in which this subject is offered: Electrical Engineering

Objective: To introduce students about construction, working and maintenance of various switchgears including circuit breakers and instrument transformers. Students will also learn about the causes and consequences of various faults and protection scheme to be employed to protect system against fault by relays and lightening arresters.

Credits Earned: 5 Credits

Course Outcomes: After completion of this course, student will be able

1. To describe basic construction and working of different type of relays.
2. To relate a given circuit breaker type with rating and application.
3. To choose proper relay and its setting for transmission line and busbar.
4. To apply level of protection for various electrical machines.
5. To recommend type of earthing system and protection strategy against over voltage faults.

Pre-requisite of course: Basic knowledge of D.C. Circuits, A.C. Circuits, Electrical Machine, Power system

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE	IA	CSE	Viva	Term work	
4	0	2	5	50	30	20	25	25	150

Contents:

Unit	Topics	Contact hours	Weightage (%)
1	**Fundamental of Protection** • Introduction • Elements of power system • Classification of transmission system • Various function and necessity of protective system • Abnormalities and fault in power system	05	08

	• Types of fault and their causes • Protection zones and backup protection • Short circuit fault calculations in lines fed by generators through transformers • CT and PT's in protection system with its application • Current limiting reactors and its arrangement		
2	**Protective Relaying System** • Introduction • Importance of relay • General requirement of relaying system • Classification of relays, Selection of relays • Terms associated with relay • Types of relay, principle of working, construction and operation of various type relay • Time characteristics of relay • Electromagnetic induction, Thermal type, Gas operated relay • Concept of over current and directional relay • Current and time setting of various types of relays • Calculation of the operating time of the relay • Testing procedure of various relays. • Directional relay, Contact arrangement of relay • Distance relay, Negative phase sequence relay, Static relay, Microprocessor based relay, Numerical Relay • Testing and maintenance of relays • Protective current and potential transformer • Principle and working of protective transformer • Necessity of protective transformer • Terms related to protective transformer • Construction of protective transformer • Classification of CT, specifications of CT's and PT's, Testing of CT and PT	**12**	**22**
3	**Circuit Breaking Fundamental** • Introduction • Circuit Interrupting devices • Isolators, Load break switch and earth switch • Line diagram of various circuit interrupting devices • Difference among various devices and correct sequence of operation, Interlocking • Types of fuse and terms associated with its • Construction, working and Characteristics of fuse • Testing, selection and application of fuse • Arc formation process in ac circuit breaker • Arc extinction and its method • Arc quenching in HVDC circuit breaker • Arc quenching in AC and DC circuit breaker • Arc interruption theory	**12**	**22**

	• Circuit breakers and its classification • Principle of working of circuit breaker • Basic elements of circuit breaker • Types of circuit breaker • Oil circuit breaker and its type • Air circuit breaker and its type • Axial and cross blast circuit breaker • Sulphur Hexa Fluoride (SF6) circuit breaker • Vacuum circuit breaker, Various LT circuit breaker • Comparison of fuse and MCB • Selection of MCCB for motor • Testing of circuit breaker • Specification and applications of circuit breaker • Selection of circuit breaker, Resistance switching		
4	**Protection of Transmission line and Busbar** • Introduction • Abnormalities and faults in power system • Scheme of various types of protection in transmission line • Different basic protective system • Over current protection, Earth fault protection, Distance protection • Time graded and current graded protection • Current balance differential protection • Requirement of carrier aided protection • Carrier inter-tripping • Acceleration and blocking scheme, Auto reclosing • Feeders and Ring mains protection, Translay scheme for feeder protection • **Busbar Protection** • Abnormalities and Fault in Busbar • Various protection schemes of busbar	**12**	**22**
5	**Protection of Transformer** • Introduction • Abnormalities and Fault in transformer • Safety devices with power transformer • Protection offered by Buchholz Relay and analysis of trapped gases • Differential and earth fault protection, Harmonic restraining in differential protection • Inter-turn and restricted earth fault protection • Protection against over fluxing and overheating • Protection of grounding transformer • Protection of different type of transformer • Phenomenon of inrush current in transformer	**3**	**6**
6	**Protection of Alternator and Motor** • Introduction	**7**	**12**

	• **Alternator Protection** • Abnormalities and Fault in alternator and motor • Various protection schemes • Differential protection • Over current and earth fault protection • Inter-turn fault • Negative phase sequence and overheating protection • Protection against failure of excitations • Field suppression, Overload protection, Overvoltage protection, Reverse power protection, Protection against stator and rotor earth fault, Over speed protection, Miscellaneous protection • Connection diagram of protection system for alternator **Motor Protection** • Requirement of protection of motor • Various protection scheme • Protection chart of motor • Short circuit protection, Overload protection, Protection against single phasing • Anti-pumping relay		
7	**Overvoltage Protection and Neutral Earthing** • Introduction • Voltage surge • Reasons of over voltage, Effect of over voltage • Methods to reduce over voltage condition • Lighting phenomenon and Lighting arrestor • Surge absorbers, Protection against travelling waves • Insulation co-ordination • **Neutral Earthing** • Introduction and importance of neutral earthing • Isolated neutral system • Neutral Earthing and its various methods • Types of neutral earthing, Earthing system • Earthing transformer • Neutral grounding	**5**	**8**

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as per follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember	Understand	Apply	Analyse	Evaluate	Create
35%	35%	15%	15%	0%	0%

Suggested Laboratory Work / Activity:

Following are the activities which can be undertaken to accelerate the attainment of the various outcomes in this course

Sr. No.	Unit No.	Name of Topics	Contact Hours
1	3	To understand CT Magnetization Characteristic.	2
2	3	To understand various circuit breaker and its specification.	4
3	2	To understand Non Directional (Induction Disc) and Directional (Induction Cup) relay and its characteristics.	2
4	4	To perform Radial Feeder Protection	2
5	4	To perform Parallel Feeder Protection	2
6	4	To understand Numerical Feeder Protection Relay Type MICOM P111.	2
7	5	To check the polarity of transformer and carried out open circuit and short circuit test	2
8	4	To perform Over Current and Earth Fault Protection of 3-Phase Feeder	2
9	5	To perform Transformer Differential Protection	2
10	6	To perform Generator Differential Protection	2
11	6	To perform 3-Phase Induction Motor Protection	2
12	4	Draw single line diagram of high voltage substation with protective scheme	2
13	7	To understand function and working of lighting arrestor.	2

Instructional Method:

a. The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

b. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.

c. Practical examination will be conducted during the semester for evaluation of performance of students in laboratory.

d. Students will use supplementary resources such as online videos, NPTEL videos, e-courses.

References:

1. S.S.Rao, "*Switchgear and Protection and Power System*", Khanna Publication, New Delhi. 2016.
2. Y.G.Paithankar and S.R.Bhide, *"Fundamental of Power System Protection",* PHI, New Delhi. 2016.
3. Y.G.Paithankar and S.R.Bhide, *"Fundamental of Power System Protection",* PHI, New Delhi. 2016.
4. Oza, Nair, Mehta and Makwana, *"Power System Protection and Switchgear",* Tata McGraw Hill Education Private Limited New Delhi. 2011.
5. V.K.Mehta "*Electrical Power System*", S.Chand Publications. 2016.
6. J.B.Gupta, "*Switchgear and Protection*", Katariya Publication, New Delhi. 2012.
7. C.L.Wadhwa, "*Electrical Power System*", New Age International (P) Limited. 2017.

Supplementary Resources:

1. https://nptel.ac.in/course.php
2. https://www.youtube.com/watch?v=Hc6Z64gFARg
3. https://www.youtube.com/watch?v=vtag4vEyHLk
4. https://www.youtube.com/watch?v=R2J1onnuOZ4&list=PLuTTwy0Txw1fgFG_RDITyfkswLjn_4Qmm&index=5
5. https://www.youtube.com/watch?v=F4iICDV2Z74&list=PLuTTwy0Txw1fgFG_RDITyfkswLjn_4Qmm&index=7